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[001] CONTINUOUSLY VARIABLE VEHICLE TRANSMISSION

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[003] The invention relates to a continuously variable vehicle transmission having one variator such as a toroidal drive or a cone pulley belt drive for continuously variable ratio and a multi-step transmission having at least one input and one output shaft and at least two forward gears and at least one reverse gear.

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[005] A similar arrangement is known from the Applicant's DE 198 58 553. It discloses a combination of one variator, one planetary transmission and a rear-mounted differential which distributes the driving power over two drive shafts. The power is branched behind the transmission input via a first branch to the variator and via a second branch and one other ratio step to the planetary transmission.

[006] Vehicle transmissions of that kind are also known, in general, from the prior art where a planetary transmission is rear-mounted on the continuously variable transmission, for example, a belt drive transmission. Said planetary transmissions are usually connected via two other spur gear sets with the axle differential of a motor vehicle, since the input and the output shafts of the planetary transmission have the same positive direction of rotation for the forward drive range and the positive direction of rotation is relayed via the inserted spur gear sets so that the drive axles connected with the axle differential also effect a positive direction of rotation during forward drive of the motor vehicle.

[007] Vehicle transmission of that kind are subject to a constant further development regarding reduction of construction cost or increase of comfort for the user of a motor vehicle equipped with such a transmission.

[008] It is, therefore, the problem on which this invention is based to indicate a design of a vehicle transmission which makes possible, on one hand, a lower construction cost and, on the other, an increase of comfort for the driver of a vehicle equipped with such a transmission. The reliability and the service life of the transmission are also to be increased.

[009] According to the invention this problem is solved by a continuously variable vehicle transmission according to the characteristic features of claim 1.

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[011] It is proposed, in a vehicle transmission of the above kind, that between the input and the output shafts of the multi-step transmission a reversal of direction of rotation takes place by means of at least two forward gears and that the reverse gear(s) be designed without reversal of direction of rotation between the input and the output shafts of the transmission. Thereby is obtained in the first place that an advantageously lower construction cost be required compared to the known vehicle transmission with two driving ranges. By virtue of the reversal of direction of rotation within the transmission between the input and the output shafts, the formerly double spur gear set between the transmission and the rear-mounted axle differential is reduced to a single spur gear set. Secondly, the invention proposes a solution which makes possible a lesser variator spreading with a larger total spreading compared to one-range transmissions. Besides, an optimum variator rotational speed is possible in the main drive ranges which are divided, for example, in a city and a cross-country range.

[012] In a specially advantageous development of the invention, it is proposed that a variator is specially provided a cone pulley belt drive transmission or a reversing toroidal drive wherein the input and output shafts of the variator have the same direction of rotation and on the multi-step transmission there is rear-mounted, for reversal of direction of rotation, a device such as a simple spur gear set with a rotational speed ratio. Thereby the negative direction of rotation of the output shaft of the transmission during forward drive of the motor vehicle is, on one hand, reversed to a positive direction of rotation and, on the other, a rotational speed ratio is made possible, at the same time, by said spur gear set.

[013] The shafts of the variator and the multi-step transmission, the same as the wheel axles connected with the axle differential, are disposed side by side in parallel. Thereby a compact construction is advantageously made possible.

[014] In one other advantageous design of the invention, it is provided that the variator be specially designed as a one-way toroidal drive wherein a reversal of direction of rotation takes place in the variator between the input and the output shaft. Such as arrangement is advantageous for vehicles with low power range.

[015] The shafts of the one-way variator, the same as of the multi-step transmission, are disposed coaxially and consecutively relative to each other so that the wheel axle of the rear-mounted axle differential extends at right angle relative to the input shaft.

[016] The input and output shafts of the transmission are advantageously coaxial to each other and situated on one or both sides of the housing of the transmission. Thereby an adaptation of the transmission to the most different installation conditions in a motor vehicle is easily made possible.

[017] The multi-step transmission is advantageously designed as planetary transmission wherein a shift clutch of the multi-step transmission can also be advantageously designed as starting clutch. Alternatively, an external clutch can also be used, such as a wet starting clutch or a dry friction clutch, a hydrodynamic converter or also any other starting element, for example, a magnetic clutch, an E-motor, or the like.

[018] The multi-step transmission is advantageously designed power shiftably so that by means of multi-disk clutches a shift under load can be effected without interruption of the traction. Alternatively, a shift can also occur with traction interruption, with synchronizations, or also with a dog clutch.

[019] The reduction ratio of the reverse gear is advantageously unlike one and, in particular, amounts to about three so that a total or starting ratio of the inventive vehicle transmission of about fifteen can be obtained. Both forward drive ranges of the vehicle transmission are designed so as to have a cutting zone so that a "city range" and a "cross-country range" can be implemented. By this overlapping of the ranges, it is advantageously possible to prevent a frequent reversal of the ranges and an optimum variator speed is always made possible in the main drive ranges.

[020] It is advantageously provided to effect a change of the drive range as compound shift so that a stepped shift in the multi-step transmission and a ratio adjustment of the variator simultaneously occur. Thus, when shifting, for example, from the first to the second range, a shifting is effected wherein the total ratio of the vehicle transmission remains constant.

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[022] Other objectives, features, advantages and possible application of the invention result from the description that follows of the embodiments shown in more detail in the drawings. All described and/or graphically shown features per se or in any logical combination form the object of the invention independently of their compilation in the claims and their reference to previous claims. In the drawings:

[023] Fig. 1 diagrammatically shows a continuously variable vehicle transmission with a belt drive transmission and a rear-mounted transmission;

[024] Fig. 2 diagrammatically shows a continuously variable vehicle transmission with a two-way toroidal drive and a rear-mounted transmission;

[025] Fig. 3 shows a continuously variable vehicle transmission with a one-way toroidal drive and a rear-mounted transmission, the same as an axle differential;

[026] Fig. 4 shows a transmission similar to the representation in Fig. 1 but with a detailed diagrammatic representation of the planetary transmission;

[027] Fig. 5 shows the switching system for a planetary transmission according to the representation in Fig. 1; and

[028] Fig. 6 shows a graphic representation of the variator ratio relative to the total ratio for the three drive ranges.

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[030] The continuously variable vehicle transmission 1 (Fig. 1) consists of one belt-drive transmission 2 as variator and rear-mounted thereon one multi-step transmission 4 which is specially designed as planetary transmission. Said continuously variable transmission is connected via a spur gear set 12 with

a rear-mounted axle differential 9 for driving the wheel axles 14, 15 of a motor vehicle.

[031] The driving power (shown by an arrow in Fig. 1) is transmitted by the input shaft 5, via the variator 2, to the variator output shaft 6; at the same time, the latter constitutes the input shaft 7 of the transmission 4. The positive direction of rotation of the input shaft 5 of the variator 2 remains positive up to the input shaft 7 of the transmission 4. In the transmission 4, as reversal of direction of rotation occurs in the forward drive ranges so that the output shaft 8 of the transmission 4 has a negative direction of rotation. The latter is reversed by means of the pinion 10 and of the wheel 11 again to a positive direction of rotation and via the input shaft 13 of the axle differential 9 is conveyed to the latter. During forward drive of the motor vehicle, the driving power leaves the axle differential 9 in positive direction of rotation via both wheel axles 14, 15.

[032] In the alternative, possible designs of the invention that follow, the same parts are identified with the same reference numerals insofar as this applies. The two-way toroidal drive 3 (Fig. 2) is driven, via the input shaft 16, in positive direction of rotation. Via both toroidal units 17 and 18, a continuously variable ratio occurs upon the spur gear 19 situated between the two toroidal units 17, 18 which has a negative direction of rotation. The latter is reversed to positive direction of rotation, via the spur gear set 22, with the spur gear 20 upon the output shaft 21 of the variator 3. The input shaft 7 of the transmission 4 and the rear-mounted parts and directions of rotation again correspond to the representation and description of Fig. 1.

[033] In the possible arrangements described above of the continuously variable vehicle transmission 1, the input shaft 5 of the variator 2, the input shaft 7 of the transmission 4 and the wheel axles 14 and 15 are disposed side by side in parallel in three-shafts construction. Alternatively an arrangement in standard construction is indicated in Fig. 3, that is, the shafts of the input shaft 5 of the variator 23 up to the input shaft 13 of the axle differential 9 are disposed coaxially consecutively. The variator 23 (Fig. 3) is designed as one-way toroidal drive so that the positive direction of rotation of the input shaft 5 is reversed to a negative direction of

rotation of the output shaft 6. The input shaft 7 of the transmission 4 thus rotates also in negative direction of rotation. According to the invention, the direction of rotation within the transmission 4 -- for the forward drive ranges -- is reversed to a positive direction of rotation of the output shaft 8. This positive direction of rotation is relayed via the input shaft 13 of the axle differential 9 to the wheel axles 14 and 15.

[034] The transmission 4 (Fig. 4) is designed, for example, as two-speed planetary gear. Here are provided four clutches A, B, C, D for shifting the two forward drive ranges V1 and V2, the same as the reverse drive range R (Fig. 5). The clutches A and D are shifted for the first forward drive range V1. To shift from the first to the second driving range V2, the clutch B is shifted instead of A. The clutch D remains closed. In the reverse drive range R, the clutches A and C are shifted.

[035] In Fig. 6 is shown upon the abscissa the total ratio i_ges of the continuously variable vehicle transmission at a constant driving rotational speed n_an. The variator ratio is shown upon the ordinate. The total ratio i_ges is divided in three driving ranges, the negative total ratio of the reverse driving range being covered with the reverse driving ratio 24. The positive total ratio in the forward drive range is reproduced in a first range with the first forward drive ratio 25, the same as the second forward drive range with the second forward drive ratio 26. Said two ranges 25 and 26 are laid out so as to overlap in an intersection area 27, that is, a "city range" and a "cross-country range" can be implemented.

[036] The shifting according to the invention takes place as compound power shift, there simultaneously occurring a stepped shifting in the multi-step transmission and a ratio adjustment of the variator. Even through this results in a momentary collapse during the shifting, no change of the total ratio i_ges results, that is, the motor rotational speed does not change. This can be seen by the fact that the total ratio i_ges at the shifting point 28 of the first forward drive range 25 is identical with the ratio i_ges adjusted after the shifting point 29 of the second forward drive range.

Reference numerals

1 vehicle transmission, continuously variable
2 variator/belt drive transmission
3 variator/toroidal drive, two-way
4 transmission, multi-step
5 input shaft
6 output shaft
7 input shaft
8 output shaft
9 axle differential
10 pinion
11 wheel
12 spur gear set
13 input shaft
14 wheel axle
15 wheel axle
16 input shaft
17 toroidal unit
18 toroidal unit
19 spur gear
20 spur gear
21 output shaft
22 spur gear step
23 variator/toroidal drive, one-way
24 reverse ratio
25 first forward ratio
26 second forward ratio
27 overlapping area
28 shifting point
29 shifting point